

TL age of loess deposits in the Yezupil I Palaeolithic site on the upper Dniester River (Ukraine)

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The Yezupil I archaeological loess site, situated in the East Carpathian Foreland (Ukraine), with two cultural layers (Middle and Upper Palaeolithic), has been systematically investigated by archaeologists and naturalists for about 20 years. These joint researches gave a very good basis for the palaeogeographical, cultural, and stratigraphic interpretation of the profile. The scope of the research included also TL analysis. The set of TL dates obtained formerly at the Lublin laboratory was supplemented with the dating results from the Gdańsk laboratory. Altogether, 28 samples were dated, enabling us to establish the chronostratigraphy of the profile. The obtained results correlate well with the European schemes of Pleistocene stratigraphy and Palaeolithic periodization. Additionally, finds connected with considerably younger (Holocene) settlement phases (Early Neolithic, Iron Age) in the Dniester River valley were dated.

Key words: loess-soil sequence, archaeological site, TL dating, Palaeolithic chronology, Dniester River valley, East Carpathian Foreland

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INTRODUCTION

The method of thermoluminescence was worked out for the archaeological use in the end of the 1950s. However, it became popular only in the 1970s when it was adapted for the dating of deposits, mostly aeolian ones. Therefore, good prospects arose for dating Palaeolithic loess sites.

Loess, as aeolian deposit, meets well the methodological requirements of TL analysis. This method is based on the assumption that the dated deposits had to be exposed to sunlight for a sufficiently long time to bleach the thermoluminescence accumulated in mineral grains during their former history. This requirement is met in the case of loess deposits. Mineral grains were subjected to air transport and exposed to sunlight in the process of loess formation (Bluszcz, 2000; Fe-

dorowicz, 2003; Kusiak, 2007; Maruszczak et al., 1992). However, sometimes it is difficult to determine in laboratory the degree of bleaching that occurred before the deposition of mineral grains, so the obtained TL age could be overestimated. Such a problem could arise when aeolian transport was too short or a deposit was involved in slope mass-movements after deposition. From the archaeological point of view, the obtained dating results are more correct if aeolian deposition was rather intensive. In such a situation, we can expect the age of the site to be close to the geological age of the deposit in which the site occurs, because the TL dates determine the phase of site covering with the next loess layer. A difference between the obtained TL age and geological age occurs when the past environmental conditions did not favour accumulation and surface deposits were exposed for some time after

the site had been abandoned by its occupants (Łanczont, Boguckij, 2002).

The TL method is also used to determine the age of archaeological sites from the Younger Stone Age and younger ones. In this case, there is a possibility of dating the archaeological finds that underwent thermal processing, such as fired pottery or loam in a fireplace or kiln. Their TL age corresponds to the time that passed since they had been fired. The main problem with TL dating of pottery is the occurrence of supralinearity of the TL glow curve. If this phenomenon is not taken into account, the obtained TL age could be underestimated (Buko et al., 2008). Because of the young Holocene age of such finds and the probability margin of the TL method, the obtained results are considered to be approximate but irreplaceable when the geological context of a given find is not clear.

The TL method was used to determine the age of the Yezupil I multi-layer and multi-cultural Palaeolithic site. The site is situated in NW Ukraine, in the Halych Prydnistroyva region – in the Dniester River valley, in the transitional zone between the East Carpathian Foreland and Podolia Upland (Fig. 1A). Numerous traces of seasonal settlement, dating to the time of the last interglacial at least, indicate that migra-

tion routes of Palaeolithic people ran along this valley. Numerous traces of younger cultures indicate that this region was still preferred as regards settlement and the exploitation of the natural environment.

In 2008, during the field seminar dedicated to geological problems of the research on archaeological sites (Łanczont, Mroczek, 2008), samples for TL dating were systematically collected from a newly cleared wall of the Yezupil I (Y.I) excavation, giving a chance to determine the profile chronology in more detail and to verify the results of former thermoluminescence analyses (Łanczont, Madeyska, 2005). An attempt was also made to determine the age of finds, younger than the Palaeolithic, a large number of which was found during the excavation works.

GEOMORPHOLOGIC SETTING OF THE SITE

Yezupil village is situated on the left bank of the Bystrycya River, near its confluence with the Dniester River, in the East Carpathian Foreland, about 40 km from the mountains (Fig. 1A). Loess deposits are widespread in the whole area, except for the bottoms of valleys. Loess is several to several

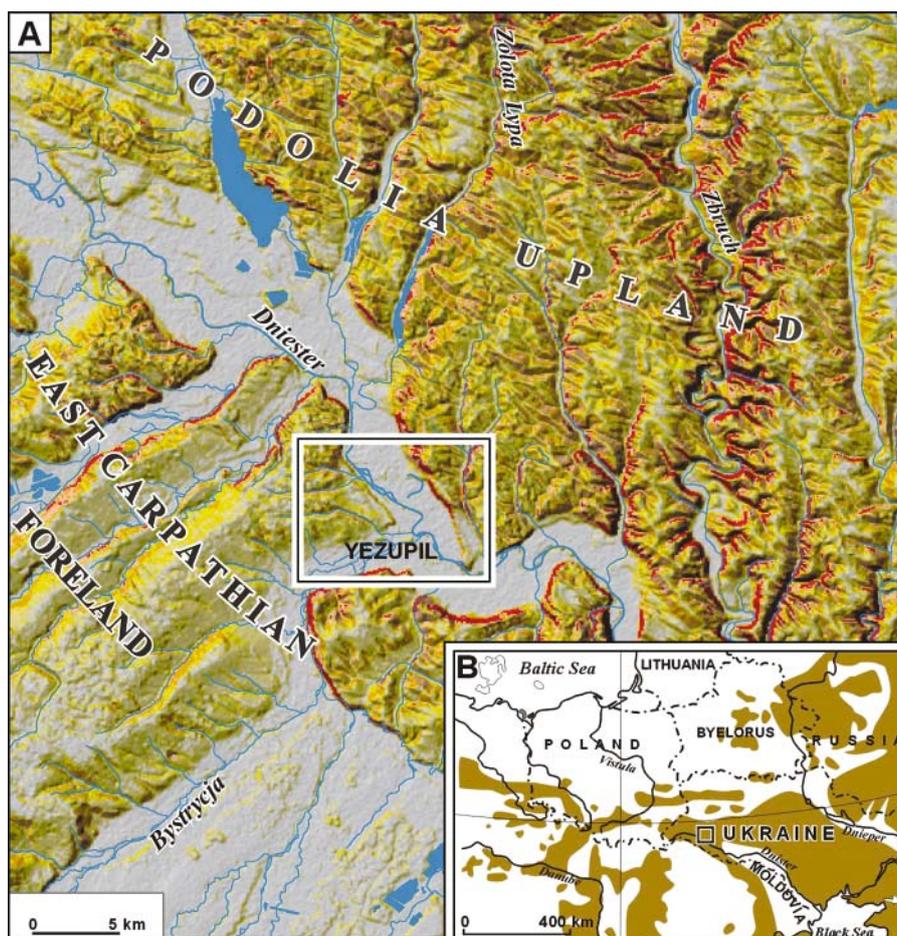


Fig. 1. Location of the Yezupil site against the background of slope angle map (A) and map of loess distribution in Central Eastern Europe (B). The extent of the detailed geomorphological map (Fig. 2) is marked on the map A

1 pav. Yezupil padėtis žemėlapyje

dozen metres thick and forms the most westerly part of the East European loess province (Fig. 1B). The Y.I site is morphologically connected with the Dniester River terrace described as the third one. It belongs to a set of Pleistocene terraces (from second to fifth) developed on the sides of deeply incised Dniester River valley. The fifth terrace is the valley edge. The steplike terrace pattern is an important feature of the landscape in the region (Fig. 2). Elements of the Eopleistocene and Pliocene relief, connected with outside-valley terrace forms, occur on interfluvial plateaux (Boguckij et al. 2007).

The third terrace rises 15 to 20 m over the river level and 230 a. s. l. It is rather narrow, several hundred metres to 1 km wide (Fig. 2). Morphologically / hypsometrically, it is similar to the second terrace, but its age and geological structure are distinctly different (Łanczont, Boguckij, 2002, 2007). The Y. I site is situated near the modern edge of the third terrace that forms a nose protruding towards the east in the junction of the Dniester River and its tributary the Bystrycya River. It should be stressed that the site location was attractive for the Palaeolithic and next occupants because the clearly isolated nose is surrounded from the southern west by the depressions belonging to the system of branched, dry, asymmetric valley of a distinctly Pleistocene origin. From the northern east it adjoins to the wide valley of the Dniester River, and to

the northern west it is gradually replaced by a long slope. The geographical position of the site is described by geographical coordinates: latitude (N) 49°02'; longitude (E) 24°46'.

GEOLOGICAL SETTING OF CULTURAL LAYERS

The Yezupil I site was discovered by A. Boguckij during a geological survey almost 20 years ago, and since then O. Sytnyk has managed systematic excavations that covered not only the site itself but also its close vicinity (exploratory excavations II–VII along the third terrace) (Boguckij et al., 2006). The archaeological research is accompanied by complex natural investigations using geochemical, palaeopedological and palaeontological methods as well as thermoluminescence dating. Those studies provide information concerning the past environment conditions and stratigraphical position of archaeological materials (Boguckij et al., 2001, 2002; Łanczont, Boguckij, 2002; Łanczont, Madeyska, 2005; Komar et al., 2008).

The great significance of the Yezupil I site for the East European Palaeolithic is connected with the well-defined position of its cultural layers in the geological profile composed of the last interglacial-glacial sequence of loesses and palaeosols (Figs. 3, 4). Three Palaeolithic cultural layers were found in this site (Fig. 3).

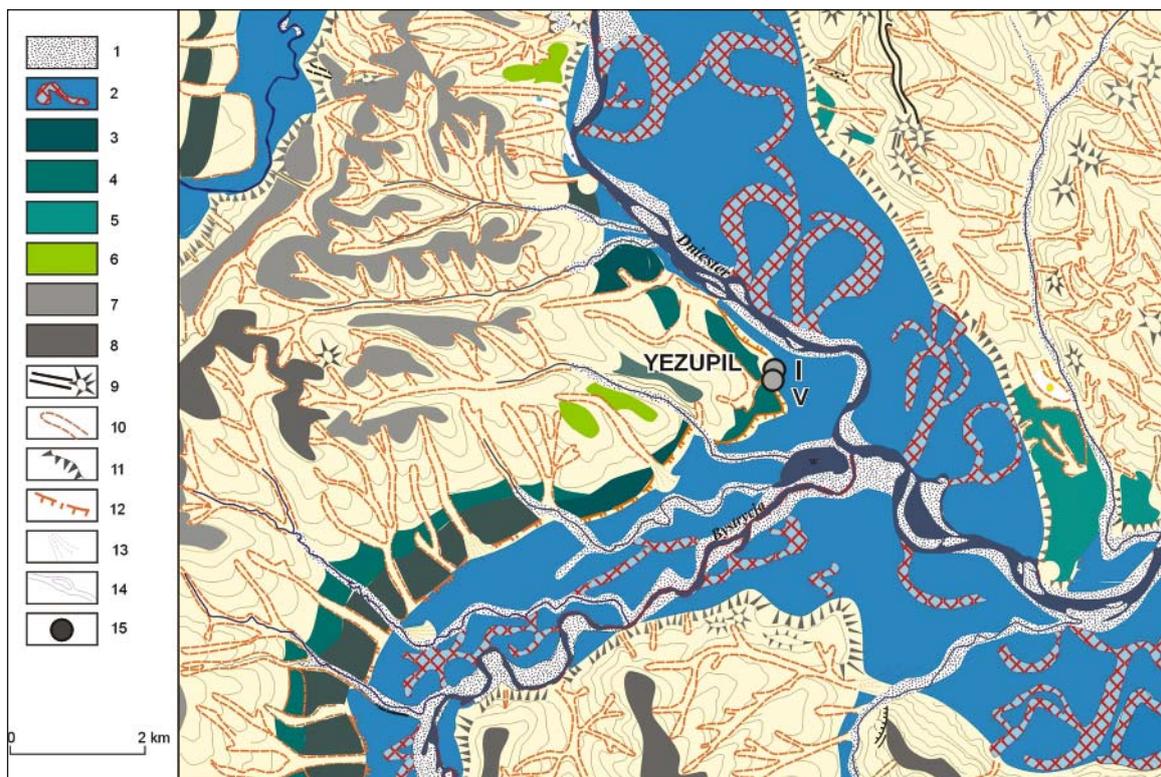


Fig. 2. Geomorphological sketch of the Yezupil site environs (according to Łanczont, Boguckij, 2002, slightly changed)

Holocene terraces: 1 – flood terrace (3–4 m); 2 – higher terrace (5–6 m) with ox-bow lakes; Pleistocene terraces of relative height: 3 – 15–20 m, 4 – 20–25 m, 5 – 45–50 m, 6 – 55–65 m; morphological planation surfaces: 7 – 300–320 m a. s. l., 8 – 320–340 m a. s. l.; 9 – denudation remnants and narrow ridges; 10 – denudation valleys and erosion dissections; erosion scarps: 11 – higher, 12 – lower (a – distinct, b – indistinct); 13 – alluvial fans; 14 – river channels; 15 – archaeological sites.

2 pav. Yezupil geomorfologinè schema

The loess-palaeosol sequence is underlain by alluvia, probably from the older part of the Wartanian Glacial. The typical carbonate loess L2, about 5 m thick, represents the younger part of the Wartanian Glacial (MOIS 6).

Over the Wartanian loess, the interglacial (Eemian) soil of forest phase developed, which is composed of the Bt horizon (1.1 m thick) and gleyed Eet horizon (0.15–0.2 m thick). The oldest Middle Palaeolithic cultural layer III (Mousterian culture with Levalloisian technique) is connected with the Eet horizon. This cultural layer is characterized by an exceptionally clear stratigraphical position. Chernozem (0.5–0.6 m thick) of steppe phase and interstadial type occurs above. Artefacts of the Middle Palaeolithic cultural layer II (Micoquian-type materials) were found in the uppermost part of this horizon, deformed by solifluction together with the loess that covered it. The chernozem horizon was generally con-

nected with the one of the Early Vistulian climatic ameliorations (Boguckij et al., 2002; Łanczont, Madeyska, 2005), but it was impossible to correlate it with particular West European warm periods ("interstadials"). In total, illuvial, eluvial and accumulation soil horizons form the Horohiv (S1) pedocomplex (1.8 m thick) corresponding to MOIS 5 (Fig. 4).

The younger loess unit L1 from the Vistulian Glacial is not very thick (<4 m) but stratigraphically differentiated. The loess directly overlying S1 represents MOIS 4. It contains a thin but distinct insert of strong gleyed material. A greater stratigraphic importance of this insert cannot be excluded because it is similar to the commonly distinguished so-called *sazhastyi* horizon (enriched with soot) which occurs in loess deposits in the vicinity of the Palaeolithic site Molodova V in the central Prydnistrovya region (Chernysh 1973). Its origin is related to fires of cold subarctic steppe.

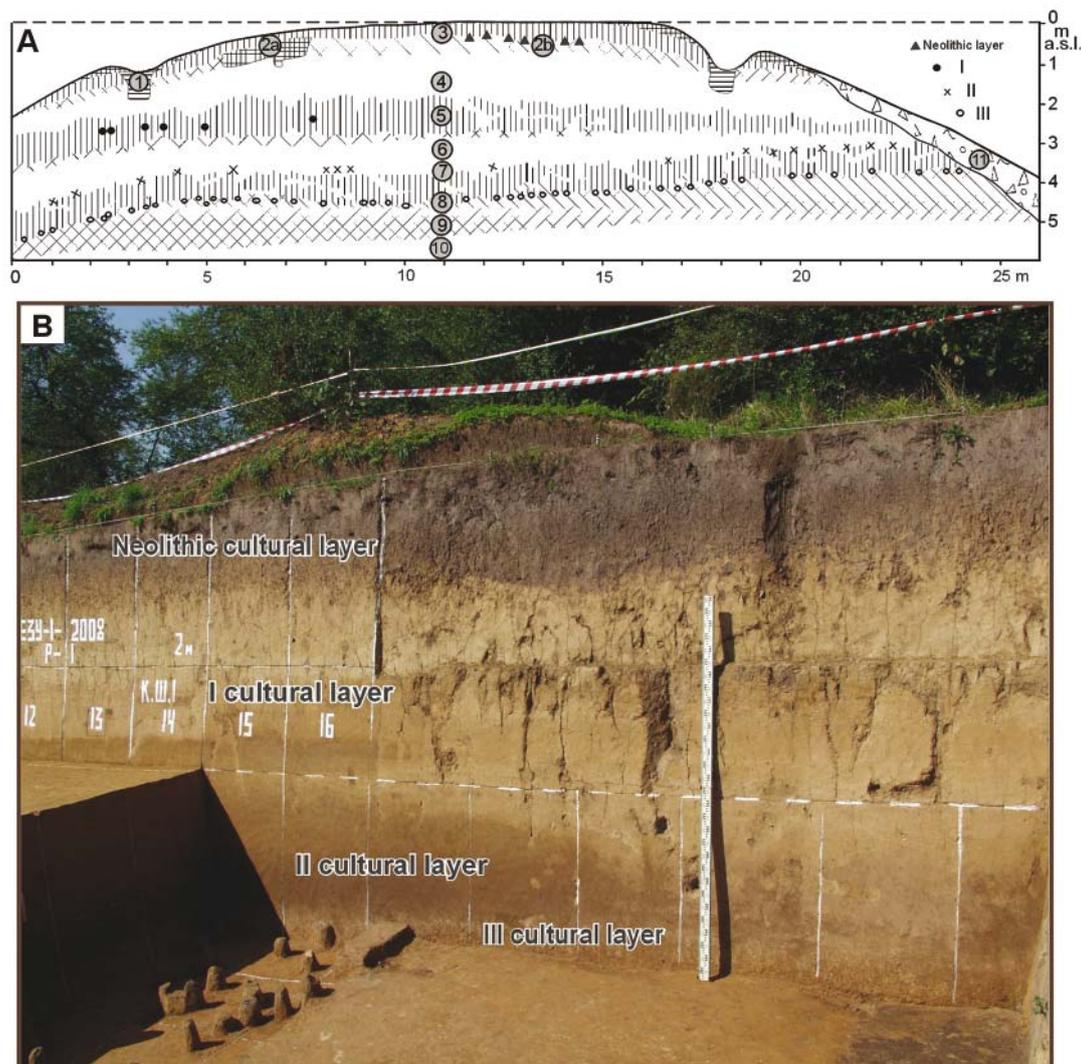


Fig. 3. A. Stratigraphic cross-section of the Palaeolithic site at Yezupil (according to Łanczont, Boguckij, 2002, slightly changed and supplemented). B. Yezupil I site. View on the excavation in 2008. I–III – cultural layers

Numbers in circlets (Fig. 3A): 1 – trenches from the First World War; 2 – settlement of the Neolithic Age: a – flint artefacts, b – pottery artefacts; 3 – modern soil; 4 – Upper Plenivistulian loess; 5 – Dubno paleosol (cultural layer I in the humus horizon); 6 – Lower Plenivistulian and Early Glacial loess; Horohiv pedocomplex: 7 – humus horizon (cultural layer II in its top), 8 – eluvial horizon with cultural layer III, 9 – illuvial horizon; 10 – Wartanian loess.

3 pav. Yezupil paleolito stovyklavietės stratigrafinis skersinis pjūvis

MOIS	CHRONOSTRATIGRAPHY		LOESS-PALAEOSOLS		TYPES OF SOILS	TL ages (ka BP) of the Yezupil I loess-soil profile		CULTURAL HORIZONS
			STRATIGRAPHIC UNITS			Lublin laboratory J. Kusiak 2003, 2007	Gdańsk laboratory S. Fedorowicz 2008 Lithology Łanczont, Boguckij 2002	
1	HOLOCENE		S0	Recent soil	Chernozem Lessive	5.98±0.42	7.2±0.9	■ Early Neolithic (Linear Pottery culture)
2	WEICHSELIAN / VISTULIAN	LATE GLACIAL	L1	Loess			25.4±2.9	Cyrek, Sytnyk, 2002 ■ Upper Palaeolithic
3		UPPER		Dubno soil	Subarctic Tundra Gley Brown	40±5	39.7±4.9	
4		MIDDLE		Loess	Initial arctic	61±8	45.6±5.2	
5		LOWER		Loess	Initial arctic	63±9	56.0±5.9	
5	EARLY GLACIAL		S1	Horohiv Pedocomplex	Chernozem	78±11	86.2±9.0	■ Micoquian type ■ Levallois -Mousterian
	EEMIAN			Lessive	Lessive	85±13	92.6±9.5	
6	WARTHE / WARTANIAN		L2	Loess		108±17	112.0±11.2	
						143±20	168.9±17.2	

Fig. 4. TL results, litho- and pedostratigraphy, and archaeological cultures of the Yezupil I profile correlated with oxygen-isotope stages (lithological description in the text)
4 pav. Yezupil I profilio archeologinių sluoksnių TL datos

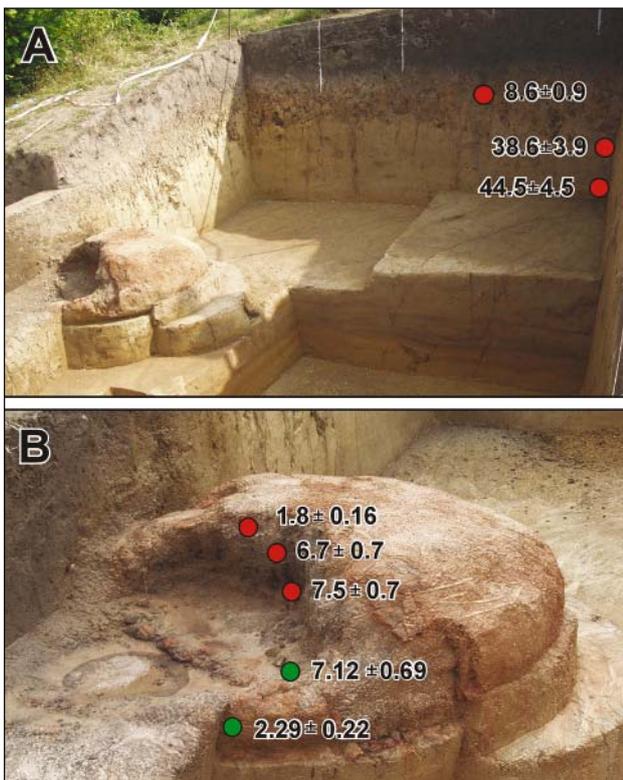


Fig. 5. Yezupil V site. A – view on the excavation in 2008. The ruins of the archaeological object – kiln cast is visible on the background of loess profile. B – TL dates (ka BP) of samples from this object obtained at Gdańsk Laboratory (red colour) and at Lublin Laboratory (green colour)

5 pav. Yezupil V profilis

Well-developed interstadial soil of brown type (about 0.9 m thick) occurs in the middle part of L1. Together with a thick gley soil it forms a catena. It is the stratigraphically important Dubno horizon in the regional scheme of loesses in the western part of Ukraine (Fig. 4). Its age was discussed. At first it was related with the younger part of MOIS 3 (Boguckij, 1987), but further investigations in the Prydnistrovya region indicated a more complex and longer history of its development (Boguckij, Łanczont 2002; Łanczont, Boguckij, 2007); at present, this stratigraphic unit is related to MOIS 3, and few subunits are distinguished within it. Few Upper Palaeolithic artefacts forming the cultural layer I were found in the middle and upper parts of the Dubno brown palaeosol (Boguckij et al., 2002).

The Holocene soil S0, occurring on the ground surface, is developed on the youngest loess of MOIS 2. This soil is characterized by a very well differentiated genetic profile. It is a complex of the Bt horizon (0.8 m thick) of forest soil with signs of eluviation in its top part, and a superimposed accumulation horizon (0.6 m thick) of steppe chernozem type soil. A cultural layer with numerous flints, which is related to the settlement of the Bronze Age, was found on the boundary between the Bt and A horizons and in the lower part of the A horizon (Boguckij et al., 2002). Fragments of pottery were found in the same position in the years 2006–2007. This cultural layer has not name of its own.

In 2007, the Yezupil V (Y. V) excavation was dug at a distance of about 150 m from the Yezupil I site, on the opposite side of a dry valley, in order to verify the geological

situation of Y. I. Investigations of the Y. V were continued in 2008. The 2.75 m thick profile of this excavation in its highest, southern part is as follows. The Holocene soil (1.4 m) is underlain by a thin (0.25 m) and discontinuous loess layer. The underlying thick (0.65 m) gley soil of the Dubno horizon covers a thin loess under which only fragments of the S1 pedocomplex are preserved in the form of layers and lenses of humus material interfingering with material of the illuvial horizon.

Three assemblages of artefacts were found in the excavation Y. V. One of them contains single flint artefacts of the Upper Palaeolithic occurring in the top part of the Dubno horizon. The second contains also single flint artefacts of the Middle Palaeolithic occurring in the lower and upper parts of the redeposited remains of the S1 pedocomplex. The next object is of quite a different origin. It is a big kiln cast in the shape of a round loaf of bread (1.1 m in diameter, 0.4 m high) burnt in loess loam (Fig. 5). The kiln was located in a hollow dug in the scarp of the third terrace. The stratigraphic context of this object is not clear as it is put into the Holocene soil, loess, and the Dubno horizon.

METHOD OF TL ANALYSIS

The TL age is the quotient of two values: equivalent dose (ED) and dose rate (DR). At the TL laboratory of the Gdańsk University, the equivalent dose is determined by the multi-aliquot regeneration method (Fedorowicz, 2006). From the total mass of each sample, a 80–100 µm fraction is separated with a sieve. The separated grains are treated with acids (10% HCl and 40% HF) for twenty-four hours in order to remove the external layer. Then they are rinsed with distilled water several times, dried at room temperature, and divided into two portions. The first portion is used for measuring natural thermoluminescence (NTL), and the second portion is bleached using an ultraviolet lamp for 6–24 hours until the grains reach the so-called residual thermoluminescence (TL_0). The zeroed material is divided into at least five portions. One of them is used to determine the residual thermoluminescence, and the others are exposed to gamma-radiation from a ^{60}Co source. Irradiation doses are selected so as to regenerate the energy received by grains in the deposit. The TL measurements are carried out using the RA'94 reader / analyser (produced by Mikrolab, Kraków). The value of equivalent dose is obtained graphically by comparison of light sums obtained from the measurements of a natural sample (NTL) and irradiated samples (NTL + UV + γ).

At the TL laboratory of Maria Curie-Skłodowska University in Lublin, the equivalent dose is determined by the multi-aliquot total-bleach technique (Kusiak 2008). From the total mass of each sample, the 45–63 µm polymineral fraction is separated using a wet sieve. Carbonates, iron compounds, and organic matter are removed using 10% HCl and 30% H_2O_2 . Then, the mineral material obtained from each sample is divided into six portions. One portion is left as natural in

order to determine natural thermoluminescence. The second portion is exposed to sunlight-simulating light for 12 hours in order to determine the residual level of thermoluminescence. The other portions are irradiated with ionising radiation doses 300 to 2000 Gy. The TL measurements are carried out using the RA'94 reader / analyser (produced by Mikrolab, Kraków). The exponential function is fitted to the obtained points employing the FIT-SIM programme (Grün 1994), which is based on the simplex fitting procedures and analytical error calculation described by Brumby (1992).

At both laboratories, the dose rate (DR) is determined from the measured concentrations of natural radionuclides (^{40}K , ^{226}Ra , ^{228}Th) occurring in a sample. The measurements are carried out using a three-channel gamma spectrometer MAZAR'95 (produced by Polon-ZOT, Warszawa). The concentrations of radionuclides in Bq / kg are converted into dose rates for alpha, beta and gamma radiation, based on the data published by Aitken (1983, 1998). At the TL laboratory of Gdańsk University, the dose rate for alpha radiation is not considered in the calculations of DR because of the used grain fraction (80–100 µm).

The following corrections are taken into account in the DR calculation:

- for cosmic radiation – based on the data published by Prescott and Hutton (1988),
- for deposit moisture – based on factors published by Aitken and Xie (1983) and Berger (1988),
- for thermoluminescence induced by alpha radiation in the fraction ≤ 10 µm in diameter ($k = 0.1$) (Aitken, 1998),
- for thermoluminescence induced by alpha radiation in the fraction about 50 µm in diameter ($a = 0.5$) (Wintle, 1987).

The TL age of the fired artefacts (pottery) is the quotient of two values: archaeological dose (AD) and dose rate (DR). The dose rate is determined from the measured concentrations of natural radionuclides contained in a sample and its surroundings (in a deposit from which a pottery fragment was taken) as a sum of components coming from alpha and beta radiation of a sample, gamma radiation of a deposit, and cosmic radiation. Corrections are made for sample moisture and a low efficiency of alpha radiation in inducing thermoluminescence. The archaeological dose is calculated as a sum of the equivalent dose (ED) and correction for supralinearity (I). At the Lublin laboratory, the ED is determined by the additive method and correction for supralinearity by the regeneration method for mineral material aliquots, which are preheated at 500 °C before irradiation (Buko et al., 2008).

TL AGE OF THE EXAMINED SAMPLES

The first attempts to determine the TL age of deposits from the loess-soil profile Y. I were made by J. Kusiak (Table 1). The obtained results enable to define the chronostratigraphic position of the distinguished loess-soil horizons and cultural

layers III–I (Łanczont, Madeyska 2005). The next samples were taken by J. Kusiak from pottery in the Y. I site (2005) and from the kiln cast in the Y. V site (2007) (Table 3). A new set of samples was collected in 2008 for the TL laboratory in Gdańsk (Figs. 4, 5; Tables 2, 3). Thus, the samples were

collected in different time. Altogether, 28 samples (20 of the Pleistocene and 8 of the Holocene deposits) were collected in both sites – the main Y. I and the auxiliary Y. V. The sampling points are shown in Figs. 4 and 5. One can see that some samples dated at both laboratories were taken from the same

Table 1. TL ages of samples from the Yezupil I profile (Fig. 4) obtained at the Lublin laboratory (2003)

1 lentelė. TL pavyzdžių iš Yezupil profilio amžius, datuotas Liublino laboratorijoje, 2003

Yezupil I site	No. Lab. LUB	Dr (Gy / ka)	ED (Gy)	TL age (ka BP)
S1 – Horohiv pedocomplex				
1 – sample of upper part of Bt horizon	3998	3.41 ± 0.24	486 ± 56	143 ± 20
2 – sample of Eet horizon	3997	3.27 ± 0.29	353 ± 45	108 ± 17
3 – sample of lower part of A horizon	3996	3.32 ± 0.37	284 ± 27	85 ± 13
4 – sample of upper part of A horizon	3995	3.30 ± 0.23	258 ± 30	78 ± 11
L1 – Vistulian loess				
5 – sample of loess directly over gleyed insert (loess of MOIS 4)	3994	3.65 ± 0.33	229 ± 24	63 ± 9
6 – sample of Bbr horizon in Dubno palaeosol	3993	3.19 ± 0.25	196 ± 19	61 ± 8
7 – sample of A horizon in Dubno palaeosol	3992	3.20 ± 0.35	129 ± 10	40 ± 5
Holocene				
Archaeological artefact – pottery fragment	4391	5.03 ± 0.15	30.1 ± 2.0	5.98 ± 0.42

Table 2. TL age of samples from the Yezupil I profile (Fig. 4) obtained at the Gdańsk laboratory (2008)

2 lentelė. TL pavyzdžių iš Yezupil I profilio amžius, datuotas Gdanskio laboratorijoje, 2008

Yezupil I site	No. Lab. UG	Dr (Gy / ka)	ED (Gy)	TL age (ka BP)
S1 – Horohiv pedocomplex				
1 – sample of upper part of Bt horizon	6112	2.22 ± 0.13	374.9 ± 39.1	168.9 ± 17.2
2 – sample of Eet horizon	6113	2.64 ± 0.12	295.7 ± 30.1	112.0 ± 11.2
3 – sample of lower part of A horizon	6114	2.58 ± 0.13	275.3 ± 28.0	106.7 ± 11.0
4 – sample of middle part of of A horizon	6115	2.69 ± 0.15	249.0 ± 25.0	92.6 ± 9.5
5 – sample of upper part of of A horizon	6116	2.72 ± 0.12	234.5 ± 25.2	86.2 ± 9.0
L1 – Vistulian loess				
6 – sample of loess under gleyed insert	6117	2.33 ± 0.20	175.9 ± 17.9	75.2 ± 8.0
7 – sample of material from gleyed insert	6118	2.38 ± 0.14	156.1 ± 16.0	65.6 ± 6.8
8 – sample of loess over gleyed insert	6119	2.41 ± 0.13	134.9 ± 13.2	56.0 ± 5.9
9 – sample of lower part of Dubno palaeosol	6120	2.55 ± 0.14	116.3 ± 12.1	45.6 ± 5.2
10 – sample of upper part of Dubno palaeosol	6121	2.52 ± 0.13	100.0 ± 9.7	39.7 ± 4.9
11 – sample of loess over the Dubno palaeosol	6122	2.37 ± 0.14	60.3 ± 6.0	25.4 ± 2.9
S1 – Holocene pedocomplex				
12 – sample of upper part of Bt horizon	6123	2.82 ± 0.16	20.3 ± 2.1	7.2 ± 0.9

Table 3. TL age of samples from the Yezupil V profile (Fig. 5)

3 lentelė. TL pavyzdžių iš Yezupil V profilio amžius

Yezupil V	No. Lab.	Dr (Gy / ka)	ED (Gy)	TL age (ka BP)
Lublin Laboratory (LUB) – 2007				
Sample of loam filling kiln	4392	4.54 ± 0.31	32 ± 2.2	7.12 ± 0.69
Sample of burnt loam from kiln surface	4393	4.54 ± 0.32	10.4 ± 0.7	2.29 ± 0.22
Gdańsk Laboratory (UG) – 2008				
Sample of lower part of Dubno palaeosols (gley soil)	6148	2.56 ± 0.14	113.9 ± 11.5	44.5 ± 4.5
Sample of upper part of Dubno palaeosols (gley soil)	6147	2.51 ± 0.14	96.9 ± 9.7	38.6 ± 3.9
Sample of upper part of Bt horizon of Holocene pedocomplex	6146	2.39 ± 0.14	20.5 ± 2.0	8.6 ± 0.9
Sample of loam filling kiln, 20 cm below its surface	6145	2.72 ± 0.13	18.0 ± 1.8	7.5 ± 0.7
Sample of loam filling kiln, 10 cm below its surface	6144	2.63 ± 0.13	17.7 ± 1.8	6.7 ± 0.7
Sample of burnt loam from kiln surface	6143	3.24 ± 0.16	5.83 ± 0.5	1.8 ± 0.16

layers but not from the same places. Due to this circumstance, the obtained dating results could be mutually verified, and a dense sampling enables specifying the age of the geological horizons.

DISCUSSION

The results of TL dating obtained at the Gdańsk and Lublin laboratories show a very good agreement. The TL ages are consistent with their geological interpretation, and the determined periods of development of interglacial and glacial complexes well correlate with oxygen isotope stages distinguished on a global scale (Fig. 4). Therefore, in our opinion, we are entitled to use the whole set of TL dates to determine the duration of development of successive natural phenomena and the age of cultural layers.

Pleistocene. Samples from the Bt horizon of forest palaeosol (corresponding to the Eemian interglacial) were dated to 168.9 and 143 ka BP, which could rather be related to the age of the mineral substratum on which the soil developed. A much more interesting result was obtained for the Eet horizon and the cultural layer III. The dates obtained at both laboratories are rather consistent (108 and 112 ka BP) and probably well indicate the time when the Palaeolithic man was active on the soil surface in the site. It was probably the younger part of the Eemian interglacial when the conditions favourable to leaching prevailed (Haesaerts et al., 1999). The A horizon of this soil is not recognisable today, probably because of humus mineralization or even denudation. The artefacts left on the ground surface at that time occur now in the Eet horizon of this soil (Łanczont, Madeyska, 2005).

The Horohiv palaeosol of steppe phase, commonly correlated with the Early Vistulian, was TL-dated to 106–78 ka BP. This age is in good agreement with the duration time of interstadials distinguished in this period. The Early Vistulian began about 116–115 ka BP (Haesaerts et al., 1999; Mojski, 1999), and the time of a warm interval of the Amersfoort together with Brörup (MOIS 5c) is 105–94 ka BP and of the Odderade (MOIS 5a) 82–75 ka BP (Mojski, 1999). Therefore, the obtained results indicate that the chernozem probably represents a significant part of the Early Vistulian period. However, due to a small supply of mineral material in stadial phases, the interstadial breaks in this supply were not recorded in the geological profile because the whole aeolian deposit had been transformed by pedogenesis. The age of the cultural layer II corresponds rather to the middle and / or younger part of the Early Vistulian.

In the Yezupil I profile, the Vistulian is mostly represented by loesses which probably accumulated in the older part of the Plenivistulian. This is the oldest period of the maximum cooling in the last glaciation (Mojski, 1999), which corresponds to the MOIS 4 dated to 72–60 ka BP (Guiter et al., 2003). The oldest obtained TL date of MOIS 4 loess in the Y. I profile is 75.2 ka BP.

In the case of the Dubno palaeosol, the results obtained at both laboratories are very consistent. This soil developed in two phases (interstadial pedocomplex). Subarctic brown soil, developed in the older phase, is dated to 62 ka BP. The superimposed gleyed A horizon turns laterally into the gley horizon. Both of them were dated in two profiles (Y. I and Y. V), and the four obtained similar results (Tables 1, 3) are from the interval 45.6–38.6 ka BP. In our opinion, it was exactly the period when the Upper Palaeolithic people migrated along the Dniester River valley. The described time corresponds to the middle part of a long period, generally less cold than the preceding period (Łanczont, Boguckij, 2007). The approximate duration of the MOIS 3 was 60–29 ka BP (Guiter et al., 2003).

At this stage of research, we consider that rather older units of loess representing MOIS 2 occur near ground surface in the Yezupil environs. In its lower layers this loess probably contains an admixture of older deposits (that is the reason of the obtained TL age 39.8 ka BP). The overlying typically aeolian loess was dated at about 25 ka BP. This fact probably indicates some denudation of the youngest loess units of the Late Vistulian or Early Holocene, the results of which can be observed in the Y.V excavation and in adjacent sites II and III (Boguckij et al., 2006, Sytnyk et al., 2008) where the loess underlying the Holocene soil was also dated at 25–24 ka BP (TL laboratory in Lublin).

Holocene. Investigations in the Yezupil environs, aimed at the Pleistocene profiles and Palaeolithic sites, gave also the results that could arouse interest of the researchers studying younger cultures. The complicated structure of the Holocene pedocomplex is also enhanced by the occurrence of archaeological material (pottery) on the surface of older soil (i. e. from the forest phase of pedocomplex development). The obtained TL age of the pottery fragments indicates that the Dniester River valley was inhabited about six thousand years ago (Mesoholocene, Atlantic period AT3 / AT2). This population can be probably related to the oldest Neolithic culture, perhaps Linear Pottery Culture (Kruk, Milisauskas, 1999). The deposit from the top part of the Bt horizon of the Holocene soil, sampled near the pottery in the Y. I site, was TL-dated to 7.2 ka BP (Fig. 4) and in the Y. V to 8.6 ka BP (Table 3, Fig. 5). Based on these dates, we can deduce that a break occurred between the development phases of forest soil and steppe soil when the pedogenesis was stopped or slowed down, probably due to a change of climatic conditions, and then its character changed. The occurrence of pottery on the surface of forest soil can be interpreted as a sign that during this break the first Neolithic farmers and breeders inhabited the Yezupil environs.

The kiln cast discovered during excavations in the Y. V site was a puzzle to archaeologists. The TL dating of its burnt loamy surface (1.8 ka BP) indicates that it was probably connected with the stay in the Yezupil region and economic activity of a population representing Chernihiv Culture (Iron Age). A very intensive settlement from this period was

discovered during exploratory works near the confluence of the Dniester and the Bystrycyia rivers. The kiln itself was probably a workshop object. The distinctly uneven topography of its close surroundings enables to expect a higher number of such objects under ground surface. This fact could indicate that a complex of kilns for public use was situated outside the hamlet.

The dark deposit filling the kiln (Fig. 5) got inside when its exploitation was finished, and it is clearly a redeposited material of the Bt horizon of the Holocene soil. Its TL age determined at both laboratories is within 6.7–7.5 ka BP.

CONCLUSIONS

The Yezupil region was an important centre of the Palaeolithic settlement. Primitive hunters were mostly attracted by its diversified relief, the vicinity of a large valley (natural route of animal migration) and an easy access to rich flint beds (excellent material for making tools). The obtained TL dates enable us to specify the time of the Palaeolithic people stay in this region.

1. Samples for TL dating were collected from the loess-soil profile Yezupil I from the same layers but not from the same places, and in different time. The results obtained at the Gdańsk and Lublin laboratories show a very good agreement and are consistent with their geological interpretation confirmed by data of several other specialists. The TL ages form a logical sequence, and cases of inversion are single. This fact enables us to specify the age of the Palaeolithic cultural layers. The obtained dates correlate well with the European schemes of Pleistocene stratigraphy and Palaeolithic periodization.

2. A good agreement of the obtained dates with the geological age, the concordance of independently obtained dating results, and the consistently decreasing age of samples up the profile seem to indicate that the conditions of loess accumulation near the site were good. Aeolian material was well zeroed and deposited by a free settling of dust with a rather small participation of syndepositional slope processes.

3. The palaeorelief analysis of the Yezupil environs clearly indicates that only in the Y.I site the topographic conditions were not favourable to intensive slope processes during the successive settlement phases (perhaps except the phase II). The other places situated along the edge of the third terrace were subjected to strong erosion processes in the post-Eemian and Late Pleistocene-Early Holocene periods. This fact can explain (?) the permanent settlement preference of the Yezupil I site in the Pleistocene.

4. The TL method was found useful for dating the Holocene deposits:

a) it revealed a break that occurred between the development phases of forest soil and steppe soil. The oldest phase of Neolithic settlement occurred in the upper Dniester River valley at that time;

b) the age of the kiln cast occurring in the scarp of the third terrace suggests that this object was connected with the economic activity of the population representing Chernihiv Culture in the Dniester River valley.

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JEZUPIL I PALEOLITO STOVYKLAVIETĖS LIOSŲ STORYMĖS TL DATAVIMAI DNIESTRO AUKŠTUPYJE (UKRAINA)

Santrauka

Jezupil I paleolito stovyklavietėje, plytinčioje rytinėje Priekarpatėje (Ukraina), slūgsančios liosų storymės, kuriose išskiriami du kultūriniai sluoksniai (vidurinis ir vėlyvasis paleolitas), archeologų ir gamtininkų tiriamos jau apie 20 metų. Tokie tarpdisciplininiai tyrimai suteikė informaciją paleogeografinėms, kultūrinėms ir stratigrafinėms storymės interpretacijoms. Viena iš tyrimų rūšių buvo ir TL analizė. Ankstesnių tyrimų, atliktų Liublino laboratorijoje, rezultatus papildė Gdanskio laboratorijoje gauta informacija. Iš viso buvo datuoti 28 nuosėdų pavyzdžiai. Gauti rezultatai leido atlikti patikimą nuosėdų pjūvio chronostratigrafiją suskirstymą, kuris gerai koreliuoja su Europos pleistoceno periodizacija, tiek ir su paleolito suskirstymu žemyn. Papildomai buvo datuoti holoceno metu susiklostę ankstyvojo neolito bei geležies amžiaus archeologiniai sluoksniai, aptikti Dniestro slėnyje.

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**TL-ДАТЫ ЛЕССОВЫХ ОТЛОЖЕНИЙ
ЕЗУПИЛЬСКОГО ПАЛЕОЛИТА В ВОСТОЧНОМ
ПРИКАРПАТЬЕ (УКРАИНА)**

Резюме

Лессовый археологический стент Езупиль I расположен в Восточном Прикарпатье (Украина), в котором выявлены три культурных уровня (палеолит средний и верхний), уже около 20 лет систематически исследуется археологами и природоведами (естественниками). Эти совместные исследования дали хорошую основу для палеографической, культурной и стратиграфической интерпретации профиля. В ходе исследований осуществлен и анализ TL. К комплексу прежних датирований, проведенных в любельской лаборатории, присоединили результаты исследований из гданьской лаборатории. В общей сложности датировано 28 образцов, что позволило определить хроностратиграфию профиля. Полученные результаты хорошо соотносятся с европейскими схемами стратиграфии плейстоцена, а также со схемами периодизации палеолита. Кроме того, определен возраст объектов, связанных со значительно более молодыми, голоценовыми фазисами отложений (ранний неолит, железный век) в долине Днестра.